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ABSTRACT

This report describes how lesson study is being implemented in one Northern California school district, drawing on research conducted in the district over 3 years via interviews with project leaders and participants; videotapes/audiotapes of the lesson study work (e.g., planning, research lessons, and lesson colloquia); workshops designed to build lesson study; and various artifacts (lesson plans, student work, schedules, and agendas). Over the 3 years, the number of participating teachers has increased from 28 to 78. The report describes three major categories of adaptations (toward a more balanced lesson study cycle, toward a greater focus on student learning and development, and toward explicit building of collaboration and shared leadership). Although lesson study is often described as a specific set of practices, (e.g., planning, teaching, observing, and revising a lesson), these practices do not guarantee that the lesson study will offer opportunities for teachers to learn. The report suggests three components that may be essential for lesson study to contribute to instructional improvement: a balanced, coherent lesson study cycle; access to content and pedagogical knowledge; and personal/collegial qualities that support learning. A lesson plan template is appended. (Contains 11 references.) (SM)

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1

Teacher-Initiated Lesson Study in a Northern California District

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ED 478 391

I. Introduction

Lesson study, the major form of professional development in Japan, has enabled Japanese classroom teachers to reshape Japanese elementary education over the past four decades to emphasize teaching for understanding (Lewis, 2002a, 2002b; Lewis & Tsuchida, 1998; Stigler & Hiebert, 1999; Takahashi, 2000; Yoshida, 1999). Lesson study (Figure 1) is a cycle of instructional improvement in which teachers work together to:

a) formulate goals for student learning and long-term development;

b) collaboratively plan a "research lesson" designed to bring to life these goals;

c) conduct the lesson, with one team member teaching and others gathering evidence on student learning and development;

d) discuss the evidence gathered during the lesson, using it to improve the lesson, the unit, and instruction more generally; and

e) if desired, teach, observe, and improve the lesson again in one or more additional classrooms. (Lewis, 2002b, p.2).

Lesson study is currently being tried in many parts of the United States (Fernandez et al., 2001; http://www.tc.columbia.edu/lessonstudy/, Lewis 2002a). Given the dismal fate of so many once-promising reforms that have been poorly understood and poorly implemented, it is important at this early stage to study its implementation, to discuss the successful and unsuccessful adaptations that are emerging, and to begin to identify essential elements. Because context matters, it is also important to identify the context-dependent supports and barriers to lesson study in order to share this information in a timely fashion with emerging lesson study sites.

Methodology and sources of data

This report describes how lesson study is being implemented in one northern California school district (acronym BASD), drawing on research conducted in the district over three years which includes regular interviews with project leaders and a subset of participants, videotaping/audio-taping of the lesson study work (e.g., planning, research lessons, lesson colloquia) and

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workshops designed to build lesson study, and collection of artifacts (e.g., lesson plans, student work, schedules and agendas).

History and overview of lesson study in BASD

Figure 2 provides a timeline of lesson study in BASD. A team of three math coach-teachers and a project coordinator – all interested in improving the teaching of mathematics – initiated BASD's lesson study effort in mid-2000, after one teacher experienced lesson study at an international mathematics conference. These four educators (henceforth "the leaders") wrote an open letter to all teachers in the district, inviting them try out lesson study. Participating teachers were asked to commit 20 hours to lesson study work over the course of the school year and to collaboratively develop and submit a lesson plan that could be shared with other teachers in the district. Twenty-eight teachers participated in the first year, organizing themselves into teams of three to five teachers. A stipend of $500 was provided to each participant for the year's work, and groups met at a time of mutual convenience, generally after school.

Leaders' initial theory of action assumed that teachers would find lesson study valuable and would continue to participate once they experienced it. Consequently, the initial plan focused on familiarizing teachers in the district with lesson study and supporting as many teachers as possible to participate in lesson study in whatever way and to whatever degree was comfortable for them.[2] Lesson study leaders offered multiple opportunities in the first year to learn about lesson study, in order to encourage broad participation within the district.

The initial district context seemed conducive to a teacher-initiated collaborative professional development effort. The district was involved in a local reform collaborative designed to engage teachers and other site-level educators in a "cycle of inquiry" focused on student data. A consortium of schools within the district conducted cross-site and cross-grade level discussions about how to support their students. The district took part in a foundation-led consortium in mathematics and literacy reform that funded the district's part-time mathematics coaches (who were part of the lesson study leadership team), provided expertise for math and literacy instruction, and helped the district administer and score a mathematics performance assessment. District administrators provided verbal support for lesson study and used district Eisenhower funds for stipends and substitutes (used during research lessons).

Local and state conditions also supported, for the most part, the district's mathematics improvement effort. The district was in its fourth year of using the same elementary mathematics curriculum. Both math coaches and teachers felt that the curriculum's problem-based approach was helpful in facilitating students' deep understanding of mathematics content. (The curriculum was one of three nationally-recognized curricula supported by the National Science Foundation to promote the reform of mathematics instruction). State accountability measures, including the Academic Performance Indicator – a

[2] Leaders offered to teach research lessons, or have teachers teach research lessons individually in their own classroom and come together as a group to discuss the lesson

quantitative ranking of state schools based heavily on aggregate SAT-9 scores and used to determine school performance sanctions and incentives – were only beginning to be put in place. In addition to the state test, the district used two local assessments, one of which was aligned with their curriculum and was administered 3 times a year so teachers could monitor student progress in mathematics.

Initially, the leaders saw lesson study as a means to create lasting change in their district and build on on-going efforts to promote teacher collaboration. With continued use of lesson study, the leaders thought lesson study might help them improve student learning. As one leader said:

> This seemed like something that could really become institutionalized almost organically.... You just have to start it and teachers would love it and so they would just keep it going. Once you could get them in the habit of collaborating, they would continue to collaborate.... I guess that might have been a naïve idea, but just kind of idealistically thinking if you can just give teachers that positive experience of collaborating together they will keep wanting to do that when they see how powerful it is.

Although few written or videotape materials about how to do lesson study were available, leaders were able to draw on assistance from local lesson study researchers at Mills College and, using one researcher's fluency with the Japanese language, Japanese materials and practitioners. Convinced that they would be able to do lesson study better by documenting their effort, local lesson study leaders partnered with the lesson study researchers to document the lesson study work.

By the 2002-2003 school year, the lesson study leaders faced a remarkably different local environment. State and federal policies both emphasized standards and accountability, and the district's new superintendent, now in her second year, had instituted an agenda of standards-based instruction. Teachers struggled with how to make sense of and use standards in their teaching, and became increasingly worried about sanctions if they did not "teach to the test." A new mathematics curriculum, seen by district lesson study leaders as much procedural than their previous curriculum, shifted many teachers' attention from building deep understanding to "covering" standards for their grade level. A state budget crisis eliminated even the possibility of funding for lesson study from the district's general fund. The district mathematics assessment that had been administered three times a year was offered voluntarily at the beginning of the year, but essentially it was put on hold for the year until it could be aligned with the new curriculum.

Despite this increasingly difficult environment, teachers' interest and participation in lesson study continued to increase in their third year of lesson study. Seventy-eight teachers from 9 schools worked in lesson study groups (up from the 28 who had volunteered during the first school year). The school that had voted to adopt lesson study school-wide during the 2001-02 school-year began its second year of implementation and chose lesson study as a key tool to implement standards-based instruction and to learn about the new mathematics

text, creating a ripple of interest in lesson study in the district. Twenty-one teachers voluntarily participated in a two-week summer institute, and at the request of teachers in year-round schools, a second (week-long) session was added so that a dozen teachers could attend during their vacation. Funds from foundations and a local reform organization continued to provide stipends and substitutes for the lesson study work, and to fund the math-lesson study coaches.

By fall of the 2002-2003 school year, two of the four founding leaders of the lesson study effort still remained as its leaders. One became the district's half-time lesson study coach (half-time classroom teacher), a new position that enabled her (with the other lesson study leaders, a math coach and a project coordinator) to keep in closer communication with the various lesson study groups across the district, and to provide more concentrated support for lesson study (for example, to visit groups in person, to share resources, and to organize district-wide meetings). The two founding leaders who moved on to other positions remained closely supportive of lesson study in their new roles, one as the principal of the first school-wide lesson study school and one as a county administrator who continued to support mathematics lesson study through various county roles.

After starting out in the fall of 2000 with a flexible "learn as we go" approach (sometimes likened by the leaders to the Nike slogan "Just do it"), by spring 2001 lesson study leaders began to talk about the need to "go deeper," to identify weakly implemented aspects of lesson study and improve the process by which teachers learned about lesson study. One leader described the shift in her own attitude:

> [I was with a group of people who] were planning these huge staff development days... where ...groups get together and every day is on a different topic. And [one person] was trying to figure out how we could ...have these groups doing lesson study. And, to me, it just felt like you can't train people how to do lesson study and have them in lesson study groups if they're only going to meet together six times over a year, not even the same group of people everyday... And I found myself ... wanting to stop them ...I said to the group, "You know, we're famous for the 'just do it, just try it... [model]." And then I found myself saying, "No, no, no! Don't just do it. You have to have all these things in place first..." ...I felt very protective about... are they going to be doing something that I don't consider lesson study and calling that lesson study, and then what are the ramifications of that? And it made me think about well, what do I think has to be in place...

Figure 3 shows how the leaders described lesson study in presentations made at two points in time (October 2001, February 2003). The underlined text in the second column shows wording changes and additions from the first to second presentations. The figure documents several changes in thinking about lesson study that occurred over this period, including an emphasis on the entire lesson study cycle (rather than just the lesson) and an understanding of lesson study as research that is based on data collection and evidence about students.

This paper describes three major sets of adaptations made over the course of the first 30 months of the lesson study effort: creation of a more balanced lesson study cycle; increased focus on student learning and development; and intentional development of collaboration and leadership.

Adaptations Set 1:Toward a Balanced Lesson Study Cycle

Researchers have characterized lesson study as three closely interdependent, balanced stages of activity – the pre-lesson planning and study, the research lesson itself, and the post-lesson reflection and study (Lewis, in press; researchers in ICME-9 post session – look up). Early on, BASD teachers heavily emphasized lesson *planning*, sometimes to the exclusion of other elements. Many teachers viewed the lesson study process as a means to developing "perfect" lessons; as one teacher noted:

> And it just seemed like in a perfect world that is the way it would be. This is the way we would... get our lessons just right. ...The name Polishing the Stone... just seemed that it fit so perfectly.

As this comment suggests, lesson study was initially more about the "stone" than the "polishing." While the leaders understood and articulated to participants the importance of the various lesson study activities (e.g., observation, data collection, debriefing, reflecting, and revising), inexperience with these activities, combined with greater experience with lesson planning, weighted the initial lesson study work toward lesson planning. This emphasis on lesson planning, rather than observation and discussion of lessons, echoes a more general characteristic of instructional improvement in the US, compared with Japan (Lewis, 2002b). However, a number of changes, described in this section, led to a more balanced lesson study cycle, either because they streamlined lesson planning, modeled and supported the elements of the cycle other than lesson planning (e.g., goal setting, data collection, reflection, revision), or because they shortened the cycle, thereby reducing the time devoted to lesson planning.

During year one, participants were encouraged to plan as many as three lessons (most groups planned one) and to submit their plans to the leaders at the end of the year. Groups reported that they had difficulty selecting appropriate topics to research and honing their topics into something that could be studied during a single lesson.[3] Although lesson study group members reported learning from and enjoying their collaborative lesson study work, the lesson study leaders found that the submitted lessons plans were of varying quality, and that they rarely captured the groups' changes in thinking over time or their learnings about the topics under study. The lesson study leaders decided there was a need for more in-depth training in lesson study, and they organized an intensive, two-week summer workshop that would provide opportunities for teachers to learn about geometry, to participate in lesson study, and to observe

[3] Although the topic is not expected to be learned by students in a single lesson, the observation and debriefing generally focuses on a single lesson; Lewis, 2002b.

experienced Japanese lesson study practitioners. One district leader later described the impact of that 2001 summer workshop:

> A lot of that [things that we've learned about lesson study] we got from the summer. Like, the role of outside experts – how valuable that can be and how it can really take it to another level and another dimension to have somebody there with really deep content knowledge. About debriefing the lesson and how to structure those discussions so that they are more directive and focusing on specific questions that you are addressing. And the role of having just outside observers participating in that discussion. Not people who are involved in planning the discussion, but their job is just to come and be observers and then to reflect on the lesson.

These workshop experiences led BASD leaders to recommend several changes in lesson study groups' work during the following school year. For example, leaders recommended that groups change the structure of their colloquia to focus on a few selected questions as the Japanese practitioners had done, to model their own lesson plans after one that had been prepared by a Japanese teacher, and to involve outside experts in their lesson study work as early as they were comfortable doing so. Teachers who attended the workshop reported that the outside specialists helped them to think differently about the assumptions behind their teaching, such as how lesson time is allotted. For example, one teacher remarked that the workshop helped her understand the value of good data collection:

> I had an interesting experience. I watched an American lesson... And...one of the things that I definitely felt was that "She is so good at her timing." That was my overall feeling, although I didn't record times or anything. I just noticed that she really allowed time for wrap-up and she had a little timer going, making sure she didn't go over and everything. But then, with the post discussion, that was the issue that came up the most – was her timing. And a couple of the Japanese men had documented minute by minute what they were doing and they had these suggestions for how the plan could be improved dramatically if she would re-allot these minutes. And I just could not believe it because I just had this feeling... You know, nothing hard and objective like what they had done, just this feeling that her timing was so great. And so, that was their point of improvement – that they thought needed to be made in the lesson. And so, it made me realize as an observer how you can just get warm feelings about some things, but it's really important to be detailed in your observation and really be critically thinking. And not just thinking about you know "Oh, the children look well-managed" and "there was time for wrap-up." I mean, you need to be thinking critically about it. That's kind of what that showed me. Because after they had talked, I totally agreed with that completely. So that was very interesting.

In addition to seeing how experienced Japanese and US lesson study practitioners collected data and observed and discussed lessons, the BASD teachers saw one lesson that was taught, revised, and re-taught at the 2001 summer institute, an experience that uncovered the revision process and revealed how the various lesson study activities built on one another to produce knowledge about student learning. From that point forward, groups were encouraged to revise and re-teach their research lessons, and the model of revising and re-teaching lessons was adopted for all groups participating in the following year's summer institute.

Developments at the school-wide lesson study site also supported the development of a more balanced and connected lesson study cycle. The school's principal, in collaboration with one of the lesson study leaders who taught at the school, developed a year-long agenda to guide lesson study work at the school. The agenda provided specific monthly meeting goals and activities and created a structure, with time allocations, that encouraged participants to devote time to each element of the lesson study cycle. The agenda encouraged teachers to begin their lesson study work early in the school year so that they would have sufficient time toward the end of the school year to reflect on and write up conclusions from their work. The power of this year-long agenda became obvious at a district-wide meeting of lesson study participants in February, when groups reported on their progress to date. The majority of groups using the agenda had selected their research topics and were planning their lessons; many other groups who were not using the agenda were just beginning to think about what they would study.

During the 2001-2002 school year, the leaders developed reflection protocols and asked groups to use them at the end of each meeting; however, in practice time often ran out before reflection took place. Leaders decided that, if reflection was to occur, they would have to build in time for it. In the second summer workshop, leaders set aside time for groups to reflect on their lessons and prepare documentation that would convey their learning. Additionally, during the following school year the school-wide site built time for group and school-wide reflections into the year-long schedule, and dedicated one monthly meeting to reflection. Teachers responded individually to written reflection prompts and then discussed them as a team. Subsequently the grade level teams reported on their lesson study work and findings to the entire staff and individual teachers were then asked to respond in writing to three questions 1) Is there a common thread or link between lessons? 2) What concerns emerge? 3) What are the common strengths and weaknesses of students? Lesson study thus became a medium for identifying school-wide strengths and challenges.

Goal-setting was yet another aspect of the lesson study cycle brought to the fore by the 2001 summer workshop. From the start of their lesson study work, the leaders knew that lesson study in Japan began by agreeing on a common goal for students. On the advice of a Japanese colleague teaching in the U.S., they purposefully "short-circuited" the goal-setting process during year one by providing a goal for teachers – "that all students will be successful in mathematics" – rather than having participants spend time defining a common

goal. By providing this goal the leaders wanted to give teachers more time to "get into the lesson study process." As one leader said:

> We knew we were skipping that [goal-setting]. Because that seemed really big to us and we didn't know how to get people from different schools in different grade levels to be able to do that.

During the summer workshop, leaders and participants began to see how the goals connected the elements of the lesson study process. When asked what was learned about lesson planning, one teacher said, "What is it we want students to learn? Define goal and work backwards to develop lesson." Other teachers noted that goals needed to drive lesson observation and mentioned goals in many other contexts of their learning: "That there are many ways to observe a lesson depending on the focus/ goals for that lesson;" to "Observe the students' response in light of the goals for the lesson. "

After seeing the vital function of goals in the lesson study process during the first summer workshop, the leaders built goal-setting into the subsequent year's activities, through including in the lesson plan template (see Appendix 1) a section to discuss content standards related to the topic and a space for evaluation of the lesson in relation to goals. (These were based on a lesson plan used by a Japanese educator during the summer workshop.) Goal-setting continued to be a challenging process over the next year, as the discussion in one group reveals:

> Teacher 33: How specifically do we want to word this [goal statement]...?
> [Teachers reviewing copy of lesson plan template.]
> Teacher 40: he just made it [the goals] very general.
> Teacher 75: We want kids to be able to carry this to other areas of problem-solving.
> Teacher 40: Yeah, these are the goals and then there are objectives.
> Teacher 75: Yeah, we're mixing it up with objectives of the lesson.
> Teacher 40: I don't think we usually do goals. I think we usually do objectives.
> Teacher 33: But we always have a goal in mind.

Sparked in part by data like the preceding, Lewis (2002b) developed a description of four levels of lesson study goals (goals for student development, goals for a particular content area, goals for a unit, and goals for a lesson) as part of a lesson study handbook used by participants used in pre-publication form at the August 2002 workshop. Leaders also designed a workshop segment in which teachers studied research lesson goals developed by experienced and novice lesson study practitioners during the prior summer workshop; participants identified the goals they found most interesting and explained why. Data from the 2002 summer workshop suggest that participants actively drew on these experiences as they engaged in lesson study.

(two quotes, from middle school group and triangle group)

Finally, the expertise in mathematics teaching brought to the summer 2001 workshop by the outside participants (particularly the experienced Japanese teachers) underlined the power of consultation with outside content specialists. One participant described the lessons taught by Japanese practitioners as "the biggest paradigm shift in these two weeks for me." Other teachers commented on the Japanese teachers:

> I really noticed how the teachers were so patient and they took their time and they accepted the children's responses. They accepted the students' language and phrases. And really valued... And that message really came across. And myself, I said I've got to cover this curriculum and I need to move on... I wasn't impatient, but I was more apt to kind of give them hints or use key responses to get them back on track. But I saw that... the understanding of the child is not going to be deep, it was surface only. And one of the Japanese teachers said, yes, that learning comes easily like that but the understanding won't be deep. And I could see that. And that was really significant to me. I thought I was very busy teaching, and covering the curriculum and going on; not giving them the proper time that they do need.

A conversation between two BASD teachers remarked on the Japanese teachers' openness to continued learning:

> Teacher 41: They also don' t have this superior attitude that once you graduate and you're a teacher, you know it all. It's not like "There is no room for improvement – I'm perfect." ...Even these master teachers who have been teaching for years and who have been doing lesson study, really took the ...feedback.
>
> Teacher 45: It makes you think that we can all benefit from the idea that when you get your teaching credential that just gives you permission to get into the room.

The summer workshop suggested some useful models for incorporating outside specialists, such as having them teach research lessons and having them collaborate with BASD teachers in planning, observing, and reflecting on research lessons. Both of these practices were employed during the 2001-02 school year, when one of the Japanese practitioners was invited back to the district to teach a series of three research lessons. In addition, with the encouragement of lesson study leaders, several lesson study groups involved outside specialists (including Japanese colleagues who had participated during the summer workshop) in their lesson work in person, by email, or through some combination of the two. These outside specialists contributed to lesson study in various ways, some of which are discussed in the next section, under focus on student learning and development. By expanding the groups' access to various resources (e.g., curricula, approaches to problems), the outside specialists streamlined the pre-lesson phase. For example, in the second school year, one group was struggling to find good curriculum materials for teaching about fractions, and consulted a mathematics specialist outside the district who e-

mailed back thoughts about several alternate ways of looking at fractions. One group member reported later how useful these ideas were for her and her group:

> ...He had us thinking about having kids.... look at fractions and think of them in terms of proportional reasoning, which isn't the way that we had been thinking about it... So he kind of like... turned our whole view around by the way he said, well, here are three possibilities – you could do it this way, this, way, or this way... So that really kind of opened our eyes....It impacted the lesson that we taught, because then we ended up doing a problem that had to do a lot with proportion. But also...it really impacted me in that... I was so stuck on thinking of fractions in a physical model representation.... Thinking of two-thirds not as the relationship between the two and the three but thinking of, oh, there's this whole piece of it and two thirds of it is... We're talking about this piece of it, you know. And not thinking about how does this piece relate to this piece? What's the relationship between these two? So that it impacted my own understanding of fractions and content knowledge, understanding and how to think about that.

Experiences like this one with outside specialists suggested that providing access to curriculum materials could jump-start lesson planning and leave more time for other parts of the lesson study cycle. From the start of the work, the lesson study leaders had recognized that Japanese lesson study starts from existing curricula, not from scratch, and they worried about the quality of lessons available to US teachers: As one leader said," We don't have that base of lessons already described and written up to use as a starting point.... We don't have that shared body of great lessons to begin from." In the following year's summer workshop (2002), the leaders provided a range of curriculum materials for teachers as a starting point for their lesson study work, including copies of standards and several curricula related to each standard (including lessons from the text adopted by the district and from additional sources). Participants discussed the relative strengths and weaknesses of the curricular materials and selected the approaches with the most potential for their students.

In summary, the lesson study model shifted from heavy weight on planning the "perfect lesson" to a more distributed emphasis on all three phases of lesson study, as the result of a number of changes, including:

- Increased emphasis on goal-setting, data collection, discussion, and reflection, after seeing these modeled by experienced lesson study practitioners and finding/developing tools to support these processes;
- Increased use of outside specialists who helped to focus and thereby streamline the lesson planning phase;

- Emphasis on revision and re-teaching of the research lesson and on year-long scheduling, leading to shorter cycles; and
- Provision of curriculum examples and background materials that provided a more advanced starting point for research lesson planning.

Significantly, as they began to emphasize the various elements of the lesson study cycle, the leaders dropped from their presentations the title "polishing the stone."

Adaptation Set 2: Focus on Student Learning and Development

A second set of adaptations was related to increased focus on student learning and development. From the very inception of the project, the lesson study leaders explicitly told participants that lesson study was "about the lesson, not about the teacher." This maxim no doubt encouraged participation and reassured participants that the point of lesson study was not to evaluate their teaching skills. Yet it could be little more than a wishful slogan until strategies had been developed that enabled teachers to focus each lesson study activity –lesson design, data collection, lesson discussion, and so forth -- on student learning and development. Not all lessons include "thought-revealing tasks," (Lesh) that enable observers to study student thinking, and elicitation of student thinking is far more typical of Japanese than of US mathematics lessons (Stigler & Hiebert, TIMSS).

The leaders knew that anticipating student responses was a central part of lesson study, and had dedicated space to record anticipated student thinking in the lesson planning template, but efforts to anticipate student thinking sometimes focused on relatively inconsequential aspects of student behavior, as an example from one group in the second year demonstrates:

> Teacher 34: [Reviewing the lesson plan template.] Now we need student responses for their individual problem solving. What might their responses be?
> Teacher 54: Calculator.
> Teacher 34: So "Can I use a calculator?"
> Teacher 54: ..I would have kids that would get into "Can we use colored pencil?" "Can we use marker?"...
> Teacher 53: Will they come back to "If we get this right, can we get some [candies being used in the mathematical task] to eat then?"... Should we put down something about what supplies we should include?...
> Teacher 34: "Can we solve it in more than one way?"
> Teacher 55: "Do we have to use cubes?"...
> Teacher 34: And that brings us to number three [the next prompt on the lesson plan template].

In contrast to these US pioneers, Japanese teachers given the charge to anticipate student thinking can draw on a variety of print resources (including the teachers manual accompanying the textbook) that provide examples of

student thinking and detailed maps of how students develop an understanding of particular mathematical terrain. For example, Japanese students learn addition of one-digit numbers that total more than ten by the "break-apart-make-ten" method (for example, to add 8 + 5, break 5 into 3 and 2, add 2 to 8 and the remaining 3 to 10), and Japanese teachers can study how individual children progress through these steps (Murata & Fuson, 2003). Teachers can anticipate and then study exactly what part of this process students don't understand: that 8 needs 2 more to make 10, that 5 needs to be split, that the remaining 3 from the five needs to be added to 10, etc.. In contrast, if students were taught 8 + 5 simply as a number fact to be memorized, there would be no obvious data to collect during the research lesson except whether students answered right or wrong. In the absence of such data, it would be hard to discuss student learning during the lesson colloquium, and the conversation might well turn to evaluative statements about the teacher ("I liked the way you did…") or about student behavior.

Anticipating student thinking is not a change that teachers can make simply because they wish to. As the following comments by a Japanese teacher suggest, capacity to anticipate student thinking depends upon knowledge of student thinking gained from one's past teaching and on curricular resources (such as scope and sequence) that help explicate how students develop mastery of a particular mathematical terrain. If US teachers have not previously taught a particular mathematical topic in ways that reveal student thinking. and if their curriculum materials (such as standards, scope, and sequence) provide minimal information about *how* students progress in their understanding, then it is difficult to anticipate student thinking, as the following e-mail exchange reveals:

> **Outside specialist**: [From a bulleted list of recommendations he made to the group about planning] Please include expected students' solutions to the lesson plan. How many solutions do you think your students [will] bring to a whole-class discussion? Do you think some students [will] bring solutions with wrong answer? It is very important to anticipate students' solution methods to plan a whole-class discussion. In other words, if you do not have any idea what kind of solutions students could find, you wouldn't be able to lead a whole-class discussion.
>
> **BASD Teacher**: [Approximately one week later] We have only begun to think about possible solutions. We started by having each member of our lesson study group solve the problem and share responses. We discovered some variations in how we solved the problem, but it is difficult to anticipate what our students will come up with...
>
> **Outside Specialist**: [Two days later] In order to anticipate what your students will come up [with], you might want to think about what previous knowledge that students could use to solve the problem. In other words, it might be a good idea to make a list of what students have learned by the time of the lesson. Throughout this process, you will be able to have a broader perspective of the lesson [by] including a scope and sequence of your curriculum. Without having clear image of students'

previous knowledge, it is very difficult to anticipate students' possible solutions.

The exchange also presages some of methods BASD teachers used to build participants' capacity to anticipate student thinking, including trying the mathematical problems themselves and reflecting on their own thinking as a window on student thinking; studying curricular resources (such as scope and sequence) for any insights into how students develop understanding of a particular topic; and collecting baseline data on student responses to find out what students understood. For example, during the second year, some groups did baseline assessments of students' understanding of particular content, in order to inform design of their research lessons. Members had their students complete various mathematical tasks which they brought to the group for discussion. This often provided surprising and useful information. As one teacher commented after administering a problem solving task to her students:

> I was surprised. My students didn't really know how to approach the problem, and what to do. They were trying to count fingers and toes... [Student] came up with 50 [the answer to the question], but they don't know how to verbalize their thought process... I think if they have a lot more of it, they may be able to do it.

Leaders also encouraged lesson study participants to complete the math task themselves in order to identify their own strategies and then to answer a series of questions intended to focus their attention on students' current understanding, their goals for student understanding, the sequence of questions or experiences that will help students achieve the goals, and students' potential responses to the questions or experiences provided in the lesson. By working on the task themselves, teachers surfaced their own misconceptions as well as those students might have, creating opportunities to correct their own understanding and to jointly develop responses to students' expected thinking.

Data collection methods modeled during open houses in the spring and summer of 2002 also provided concrete examples of how to focus on student learning and development. During the spring open house, a Japanese educator taught a sequence of three lessons on area and perimeter to the same class three days in a row. A team of US teachers worked with the Japanese teacher each day to plan, observe, debrief, and revise the series of lessons. They reported that the collaborative experience helped them learn more about what to watch for and how to collect data during a research lesson. One technique that teachers found powerful was to follow the same student or group of students through the entire lesson to document how the students' learning developed, and the particular problems, materials and comments that sparked (or impeded) student thinking. One lesson study leader who was a member of this group later told members of her own group several things she had learned:

> One thing that I was doing (when I observed another lesson) was I was writing down everything that [the teacher] said. I think it would be good for one of us to record the flow of the lesson – if there's a misconception we can go back to see what was the language and what led to that. I think we're learning that this is valuable.
>
> One thing that helps in the data is to divide the group up and follow the same kids through the whole lesson. Otherwise you miss any big leaps or changes that those kids might have.
>
> One of the things that [outside specialist] shared with me when he was here and did those lessons... I said "How do you get to exactly the right point at the end of every lesson, because I always feel like I have this lesson plan and I have to follow it and I can't let down my group. How do you get so that you are always at a good ending point?" And he goes, "Because I never think about the lesson plan when I teach. I'm just teaching the kids and following the kids and that's what guides me, is where they're at and what do I need to do to make sure that I'm moving them along and moving their mathematical thinking." He goes "Forget the lesson plan." ...where the lesson goes is where the kids are at.

Given that the lesson study effort had begun just two and a half years earlier with the name "Polishing the Stone," the leader's realization that lesson study was about the student learning (and adult learning), not about the lesson plan itself, is noteworthy.

Adaptations Group Three: Collaboration and Leadership

A third set of adaptations centered on the systematic development of collaboration and leadership. Initially, the leaders had assumed that the benefits of collaboration would be obvious to participants and that the skills of collaboration would be learned naturally as groups worked together. However, negative experiences in some groups during the first year led the leaders to offer explicit tools to support collaboration. Drawing heavily on written materials (especially *How to Make Meetings Work* by Doyle & Strauss, 1977), the leaders provided activities and tools to help participants develop group norms. For example, participants brainstormed characteristics of effective working groups. Each day, groups were asked to choose a norm on which to evaluate the group's work. They were also asked to assign and rotate roles of facilitator and recorder. These activities met with varying success during the summer workshop, but were recommended to groups again during the following school year. One leader described the on-going challenges to these approaches:

> ...When we asked people to pick a norm for their group and to monitor that norm as they met, I think people felt like it was superfluous; that just wasn't necessary. That we're asking them to do something extra that they weren't really connecting to. And I think it's because their groups weren't having problems, so they didn't see a need for the norms, you know.

> ....The roles were a little bit more successful... but ... maybe ....people are at point where they see the need for it. [In October, one group] wouldn't even pick a facilitator. They're like "oh no, we don't need a facilitator." .... They just didn't think it was necessary. Nobody was comfortable doing it and, you know... So, like, they all just wanted to be equal and not one person was going to be the facilitator. So I think it's kind of that, you know, they're not going to get it until they're ready for it; until it becomes necessary.

In addition to building collaboration within lesson study groups, the leadership team sought to build collaboration among all participants in leading the project. Participants shared their reflections on the lesson study work at mid-year and end-of-year meetings designed to develop shared district-wide understandings of the progress and needs of the work. Both to help relieve time pressure on the core leaders and to "spread the wealth" provided by leadership opportunities, leaders frequently tried to recruit other participants as co-leaders of the work. At the October 2003 workshop, one district leader said:

> This work is done by discovery. We're counting on you to help us learn how to do this work better. We're all figuring it out together, not just [leader 1] and I. Everyone has equal responsibility for making this work. It's what makes this work exciting – that it's teacher driven.

The sustained invitation to participants to share project leadership – and teachers' willingness to carry the leadership baton – has greatly shaped lesson study's unfolding in the district. During the 2001-2002 school year, teachers who had participated in lesson study the prior year and during the summer workshop were asked to facilitate lesson study groups, helping new participants understand difficult issues such as how to focus data collection and how to structure a debriefing session. In the 2002 October workshop, participants once again took a leadership role in modeling lesson observation and data collection to colleagues new to lesson study. Commenting that their own lesson observation and data collection training had been unsuccessful because they were asked to use a videotaped lesson, a lesson study group that had worked together in August volunteered to re-teach their research lesson for October workshop participants to observe. The group described the revisions they had made, what they had learned, and where new participants might want to focus their attention during observation. As one teacher instructed her colleagues:

> I thought lesson study was building beautiful lessons. We thought the idea was to have perfect lessons, but really what lesson study is about is observing students' reactions. We totally missed the boat on studying student learning and thinking. That's going to be our emphasis this time. How interested are they? How are they working together? Are they learning?

Later, a lesson study leader commented on the value of teacher leadership for the new participants:

> Having ... the teachers there who had done it, too, and their individual testimonials about things, was also powerful....-- to hear both teachers talking about the content that they had learned as they did the lesson as well as the insights that they got in the process of doing the lessons and things that they had to reflect on it and think about doing better. ...Their modeling made it ... comfortable for people to say "oh it's okay for me, too, to share, or to realize that I am going to learn about content here and I am going to learn about, you know, whether worksheets are effective ...and it's okay to say "oh, I didn't really understand this about algebra."

Paths of Lesson Study Impact

What is our theory of action of lesson study? How do we think the activities of lesson study result in instructional improvement? It has been suggested that lesson study improves lesson plans and creates a shared body of knowledge about instruction (Hiebert et al., 2002; Stigler & Hiebert, 1999). Interviews of teachers in Japan suggest a number of additional pathways by which lesson study works, summarized in Figure 4. Japanese teachers report that lesson study affects not only their knowledge of content and of teaching, but also their "eyes to see students" (capacity to observe and understand student learning and development), their connection to colleagues, their consideration of long-term goals and connection of goals to daily practice, and their motivation to improve (see Lewis 2002a,b). While it may be tempting to define lesson study as the set of practices contained in Figure 1, the set of practices does not guarantee that the pathways of impact shown in Figure 4 will be created for participants.

Our interviews and observations in BASD include examples of development along all the paths in Figure 4. A kindergarten teacher describes, for example, how the two-week summer workshop altered her view of her practice and of her own responsibilities as a teacher.

> I think a way I'm going to change is... As a Kindergarten teacher, I was always very focused on the standards. Of course, that was only the Kindergarten state standards. ...And I always thought "I like teaching Kindergarten because... I know enough. I don't need to learn any math. I know enough because I teach these five year olds." And I just realized this week... I mean, when I saw that first grade example [of a lesson planned by Japanese teachers], they weren't thinking first grade math in their heads. I mean, they knew the standards all the way up. In their heads, they were probably going as far as they got in math. I mean, to me, it would be like high school math. And that's what they were thinking. ...I feel like I've been teaching with such a narrow perspective. Like "This is all I need to know to teach them."..." I really didn't understand the first week [of a two-week summer workshop] why we kept spending an hour or two on geometry. It was like "Who cares, I'm not going to teach this in Kindergarten." And then I realized, "No, I need to know the whole picture." ....I always thought "I know enough." ....I feel ashamed that that

is the way I've been thinking. ... that X and Y grid, where we were plotting points... It's only occurred to me as we're doing this that's why I play that game with the kids where they get to eat the M&M on A3 if they can find it. And it's like how much deeper, could I have introduced that game, talked about that game, extended that game... It wouldn't have just been a fun game ... It would have been like a building block to do that when they get to it in fifth grade....

Essential Elements of Lesson Study

What lesson study elements are essential if it is to have impact through the paths above? While study of more sites is needed, our case study leads us to notice three types of elements that have contributed to the robustness of the lesson study effort—that is, to its capacity to support teachers' development along the pathways noted in Figure 4, and to sustain itself and improve over time. These elements are: a balanced, cohesive lesson study cycle; access to content and pedagogical knowledge; and personal and collegial qualities that support learning.

1. A lesson study cycle that is balanced, coherent and responsive to needs

Lesson study is a research cycle, in which teachers collaboratively consider their goals for student development and learning, bring these goals to life in a research lesson, study student learning and development during the lesson, and share data gathered during the lesson, discussing its implications for teaching the particular topic and for instruction more generally. Like other kinds of research, its quality depends upon the quality of each element: whether the goal is important and well-defined, the lesson well-designed to reveal students' thinking, the data thorough and collected from various viewpoints, the discussion successful in drawing out the implications and limitations of the data, and so forth. Many of the adaptations made by BASD were designed to strengthen various elements of the lesson study cycle, to connect the work to local needs, and to strengthen the focus on student learning that enables the cycle to yield useful information. Well-designed processes of observation, data collection, reflection, and so forth can produce findings of interest that naturally propel other stages of the work. A number of the adaptations in BASD were designed to make the cycle more balanced (i.e., to emphasize goal-setting, data collection, discussion and reflection as well as the lesson planning); more coherent (i.e., to relate the lesson to standards and the adopted text); and more responsive to local needs (i.e., connection of lesson study to standards-based instruction and other district initiatives). A key element in a coherent lesson study cycle is a focus on student learning throughout all the phases (lesson design, data collection, discussion, revision), and another set of adaptations in BASD increased the focus on student learning.

2. Access to Content and Pedagogical Knowledge

Without access to excellent "knowledge for teaching," lesson study participants could simply spend their time polishing ineffective instruction. The BASD leaders actively involved many outside specialists in mathematics education and in lesson study. The Japanese mathematics teachers, who introduced surprising approaches and assumptions about mathematics teaching and learning, were seen by BASD teachers as providing a particularly strong "jolt" of learning.

3. Personal and Collegial Qualities that Support Learning

Ideally, lesson study is a self-sustaining cycle that deepens over time, as the experiences of one cycle increase teachers' skill at lesson design, data collection and discussion, their sense of efficacy, their awareness of how lesson study has helped their practice, and their enjoyment of working with colleagues. These kinds of qualities comprise the third set of essential components. Personal and group qualities, such as desire to improve, openness to new ideas, capacity to work together, and sense of efficacy no doubt influence lesson study's course, and are also influenced by it. For example, the good collaborative relations among BASD educators at the outset of the lesson study work (which had been developed through their prior collaborative work to improve mathematics instruction) created an openness to work with Japanese teachers introduced by the Japanese-speaking BASD leader. In turn, the collaboration with Japanese teachers led to a wealth of learning about lesson study practices and about mathematics teaching, which gave teachers good tools to improve their lesson study work, and in turn a greater sense of efficacy and pleasure in their collaborative work.

Conclusions

This case study traces the course of a lesson study effort in a Northern California school district over its first 30 months. The number of participating teachers has increased from 28 to 78 over that time. Three major categories of adaptations –toward a more balanced lesson study cycle, toward a greater focus on student learning and development, and toward explicit building of collaboration and shared leadership are described. Although lesson study is often described as a particular set of practices (e.g., planning, teaching, observing and revising a lesson), these practices do not guarantee that the lesson study will offer opportunities for teachers to learn. We suggest three components that may be essential for lesson study to contribute to instructional improvement: a balanced, coherent lesson study cycle, access to content and pedagogical knowledge, and personal/collegial qualities that support learning.

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Figure 1. Lesson Study

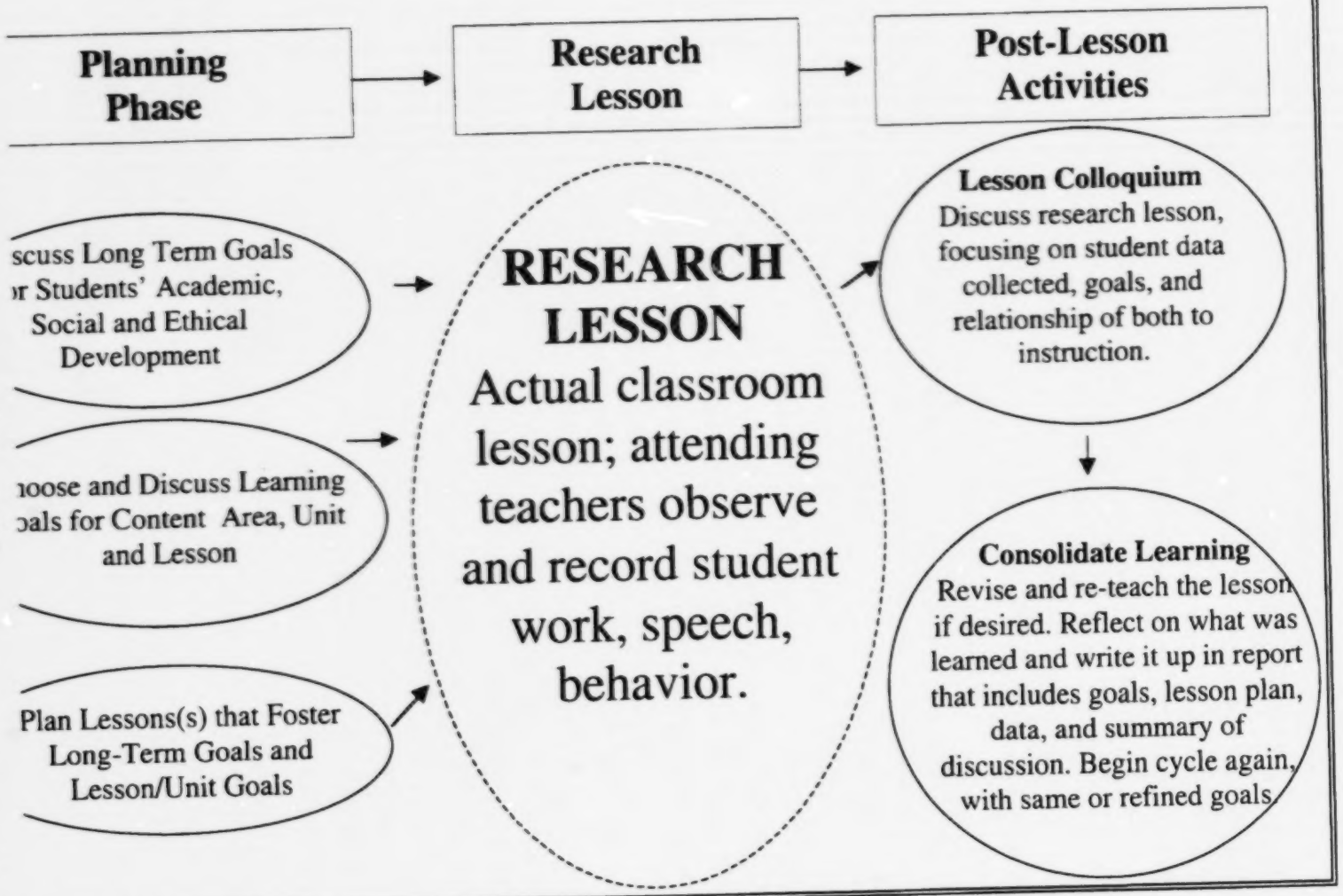
Planning Phase
Research Lesson
Post-Lesson Activities
scuss Long Term Goals
ır Students' Academic, Social and Ethical Development
ıoose and Discuss Learning
ɔals for Content Area, Unit and Lesson
Plan Lessons(s) that Foster Long-Term Goals and Lesson/Unit Goals
RESEARCH LESSON
Actual classroom lesson; attending teachers observe and record student work, speech, behavior.
Lesson Colloquium
Discuss research lesson, focusing on student data collected, goals, and relationship of both to instruction.
Consolidate Learning
Revise and re-teach the lesson if desired. Reflect on what was learned and write it up in report that includes goals, lesson plan, data, and summary of discussion. Begin cycle again, with same or refined goals.

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Figure 2. Lesson Study Timeline in BASD

August, 2000 to May, 2001 "Year One"	➢ Lesson study implementation during the school year – 28 teachers in 7 groups participate ➢ Collaboration begins with Mills College researchers
December, 2000	➢ District-wide meeting of participants to evaluate progress and make necessary adjustments
August, 2001	➢ Summer Institute I: 20 teachers study and experience lesson study ➢ 6 Japanese and 4 American "outside experts" join institute to collaborate
Sept 2001 to May, 2002 "Year Two"	➢ Lesson study implementation during the school year – 58 participants, 1 school-wide site
December, 2001	➢ District-wide meeting of participants to evaluate progress and make necessary adjustments
April, 2002	➢ Lesson Study Open House/Conference – 5 BASD teams held public lessons, 1 Japanese educator taught public lessons
June, 2002	➢ District-wide meeting of participants to evaluate progress and make necessary adjustments
August, 2002	➢ Summer Institute II: 21 teachers study and experience lesson study, conduct lessons ➢ 3 Japanese educators join institute to collaborate, teach a research lesson
October, 2002	➢ Institute III: 12 year-round teachers study and experience lesson study ➢ 1 Japanese educator; 2 US "outside experts" join institute to collaborate, teach research lesson.
Sept.,2002 to May, 2003 "Year Three"	➢ Lesson study implementation during the school year - 78 participants, 1 school-wide site
January, 2003	➢ District-wide meeting of participants to evaluate progress and make necessary adjustments

Figure 3: What is Lesson Study? Two Points in Time

October, 2001	February, 2003
• Setting a goal for students; • Planning a "study lesson" (with a detailed lesson plan) which they will use to examine their chosen goal; • Teaching the study lesson in a real classroom while other teachers observe; • Debriefing to reflect on the instruction witnessed and discuss what it taught them about the goal they set out to explore; • Revising and re-teaching the lesson (when appropriate).	• Selecting a challenging concept to address; • Articulating the concept within the content standards; • Planning a "research lesson" (with a detailed lesson plan) which they will use to examine their practice; • Teaching the study lesson in a real classroom while other teachers observe and collect data about student understanding; • Debriefing to reflect on student learning; discuss what is observed and the evidence of student understanding; • Revising and re-teaching the lesson (when appropriate); • Compiling the lessons learned about content and teaching practice.

Figure 4. Paths of Lesson Study Impact on Instruction
(from Lewis 2002a,b)

Increases in Teachers':

- Knowledge of content and of teaching
- "Eyes to see students" (Capacity to notice and understand student learning)
- Connection to colleagues as resources
- Consideration of goals and connection of goals to daily practice
- Motivation to improve, sense of efficacy, agency and responsibility

Appendix 1 – Lesson Plan Template

Mathematics Lesson Plan for Grade __

1. **Title of Lesson:**
2. **Goal:**

3. **Relationship of the Lesson in the California Mathematics Standards**

Grade Two

Grade Three

Grade Four

Grade Five

4. **What do students already understand about this topic? What more do we want them to understand?**

5. **Lesson Description**

Student Activities	Teacher Support Anticipated Student Responses	Points of Evaluation

6. **Evaluation:**

7. **Data points during the lesson observation:**

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